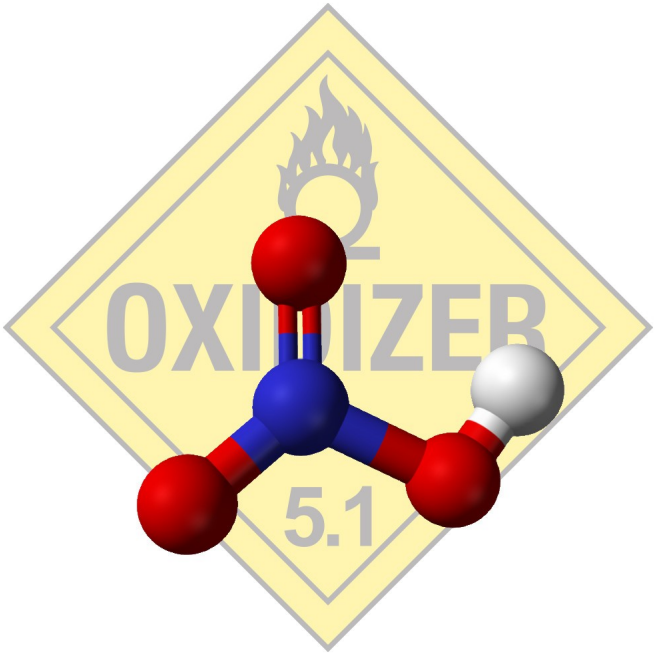
HNO3 Birkeland kit 50W version 2022

By Feanor,



Version 2022 :
This version is able to produce near 20grams of HNO3 per 24 hours (depend on conditions : electrodes spacing, size, water height level, temperature...).

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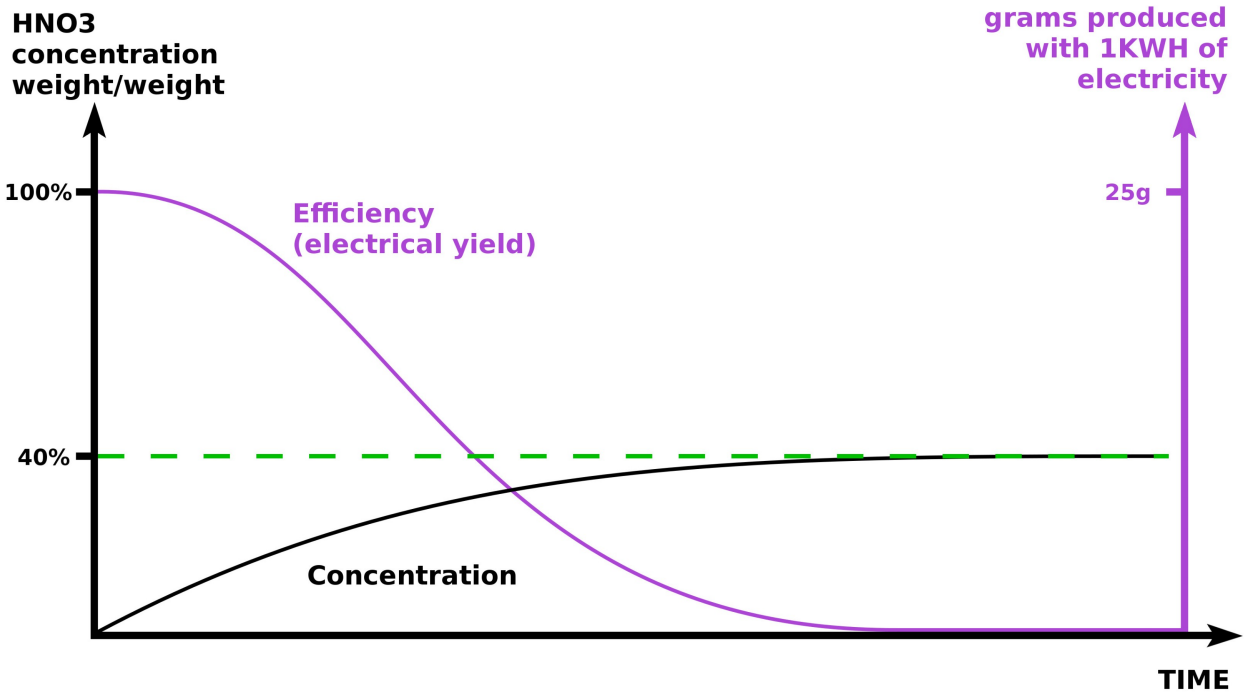
Principle :

The principle is to produce nitric acid (HNO3), from the ambiant air, by heating it to plasma, « near 3000°C » by using the following reactions : $N_2 + O_2 \longrightarrow 2\,NO$, then $2\,NO + O_2 \longrightarrow 2\,NO_2$
Who is able to react with water : $3\,NO_2 + H_2O \longrightarrow 2\,HNO_3 + NO$

Birkeland approximate efficiency



The circuit is the following :

- Air pump suck up fresh air
- send it via smal PVC tube
- to the reactor in borosilicate glass (high temperature)
- a power supply (PSU) high voltage send the current through the copper electrodes inside the flask
- the fresh air-flow is passing inside the electric arc
- the hot gases are sent to the « waiting bottle » via a PTFE tube
- the gas (containing reddish NO2) are sent to the bubble tower
- the water inside the « bubble tower » become nitric acid at low concentration (more or less never over 40/50 % in industrial set, and more or less never over 20 % here.)

→ **The process is SLOW !!!** you have to be patient ;-)

The elements of the kit :

Step 1 :

The electrodes, in copper rods, are already in the right shape.

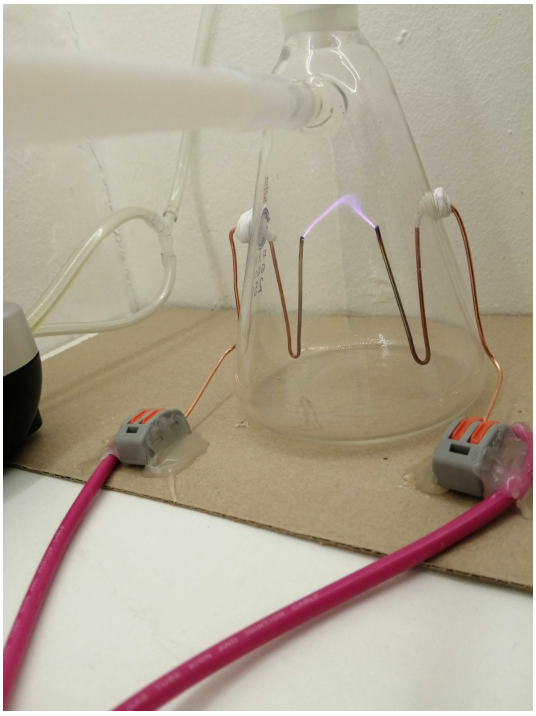
The PTFE tape is used to roll up the white plugs which will fit in the holes of the glass reactor.

The goal is to give them pressure airtight (approximately 0,2 bars).

Step 2 :

The copper electrodes are put like this, connected with the « push terminals », preferably glued on a rigid surface.

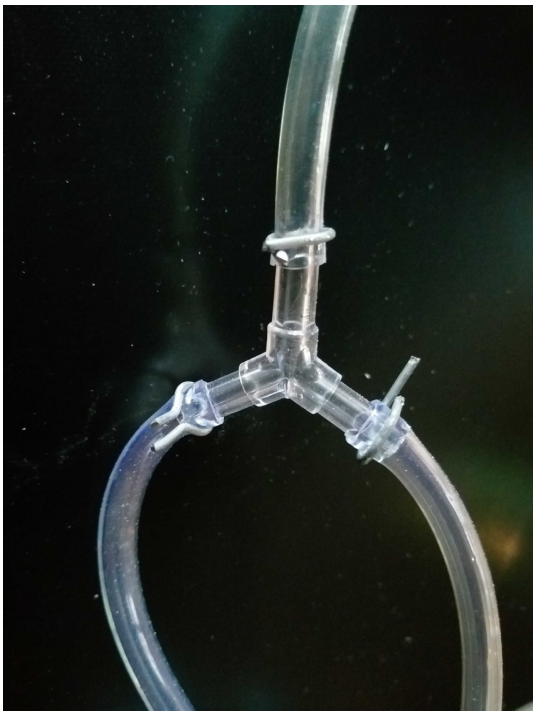
Connections must be airtight, you can check by applying pressure with your mouth.



Step 3 :

The 2 outlets of the air pump are connected with 2 parts of 10Cm from the 6/4mm PVC transparent tube to the « triple connector » toward the 30Cm remaining part of the tube.

Tip : you should crimp the tube with iron wire because along days, tubes tend to disconnect.



Step 4 :

The 30Cm tube is plugged into a 6/8mm PTFE rigid tube (6~8 Cm for example), himself plugged into a thick PTFE washer.
Only the jonction PVC tube to PTFE tube need tape.
I suggest 1 to 3 turns of tape around the washer in order to lock it properly into the neck of the glass reactor.

Step 5 :

And this part is plugged at the top of the flask (the glass reactor).

(In fact, the 8/6 tube is quite far from the electric arc, you could bring it closer to enable the flow of fresh air to pass through more directly.
Or change the shape of the copper electrodes, if you feel, to bring the arc higher.)

The side arm is connected to a 10/8mm tube of 5Cm, in which is stuck the 8/6 PTFE tube of 25Cm (for example).

(The total length of the 10/8 rigid ptfe tube is 20 Cm and you need 4 parts. I sugest to cut 4Pcs of 5Cm)

Step 6 :

The 2 « Pagoda Joints » (or cable gland) are wrapped in PTFE tape.

Step 7 :

The reacted gas should stay more than 3 minutes if possible to react the NO with O2 to form NO2.

I suggest a Polyethylene jar of 5Liters, with a hole of 10mm at the height of the arm (near 90mm for this model) and finish the hole with a round grinding file if necessary.

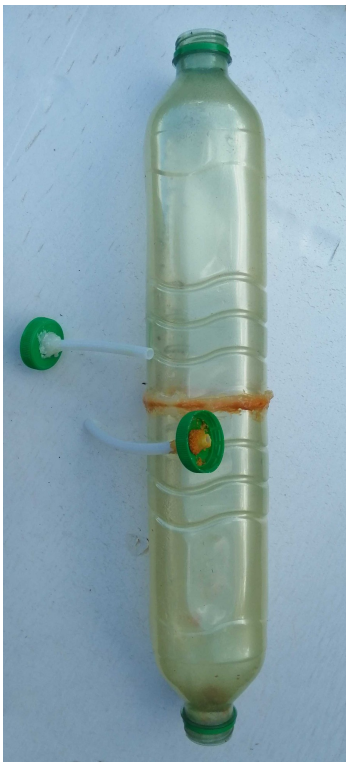
My tip is to pass a string into the new ring, in order to make sliding the Pagoda joint easily !

Step 8 :

Like this, plus the nut and it is done.

Step 9 :

Another kind of my old try : two PET bottle glued with epoxy : it works but the strong acidic gas degrade the epoxy along weeks and finally pass through.
(And colors the final HNO3 in yellow : not good at all).



Step 10 :

Another example.
This way, only with PTFE tape is better.
I never tried myself but one of my German friend did it with success.

Step 11 :

The gas bubbler just need the simple connexion to the 6/8 PTFE remaining tube.

Tip 1 : Be careful, the glass arm is quite weak, be prudent and clamp the straight part with one hand, to push the tube with the other.
The curved part may break if the force passes through.

Tip 2 : after the start of the pump, wait something like 15/30 seconds before plunging the bubbler in the water, when you are sure that the pressure is ok, to prevent the water to fill it back.

Tip 3 : you should cover the top of the jar to keep drops of projection.

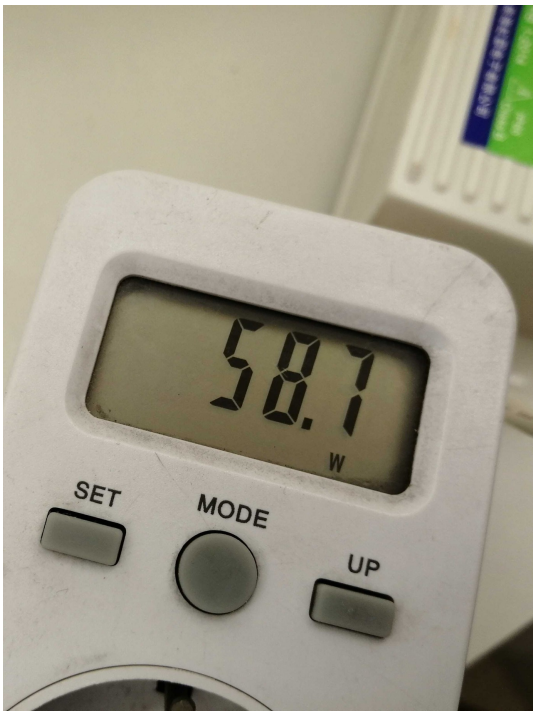
Step 12 : And finally :

Step 14 :

The absorbed power of the transformer is important. This power is directly linked to the space between the copper electrodes.

I suggest 20mm of spacing, for a consumption of more or less 40 Watts.

I get close to 60W power near 30/35mm but the power supply will probably burn faster close to his limits.



About nitrates :

You can easily produce many nitrates with dillute HNO3.
The better way, is to directly put an hydroxide in solution, in the receiving jar (bubble column).
I haven't tested this way, the only issue might be the stickiness of the water and the difficulty for the bubbles to form tiny bubbles.

- For KNO3, potassium nitrate : put potassium hydroxide or carbonate until the pH is close to 7.
- For NaNO3, sodium nitrate : put sodium hydroxide or carbonate until the pH is close to 7.
- For NH4NO3, ammonium nitrate : put ammonia (solution) until the pH is close to 7.
- Etc

The final stage required to evaporate the solution to harvest the solid nitrates.

You should help by using the pH paper or the Bromothymol blue to notice the point of acid/base (under or over pH = 7).
My youtube video about Bromothymol blue : https://www.youtube.com/watch?v=TgklSLSd-g0

Fun fact : especially for potassium nitrate from KOH, the color change from yellow/brown at pH >7 (excess of hydroxide), to pure transparent solution for pH ≤ 7.
I don’t have the explanation at this moment ;-)

Some examples :

(The NaNO3 was produced by contaminated HNO3 with epoxy decomposition, if I recall correctly, thus, the color).